

best adapted; and by reasoning equally clear it may be shown that when the load is equally diffused over the horizontal roadway of the bridge, the form of the arch should be a *parabola*. And, lastly, if the load is diffused equally over the extrados, the curve of the arch should be a *catenary*. At least, such are the forms assumed by the line of pressure under such circumstances. Now in a bridge erected for traffic, the load occasionally occupies the haunches' vertex, or it is equally diffused along the horizontal roadway, so that the line of resistance in the arch must, whilst the load is undergoing these several positions, assume the *ellipse*, *Gothic*, and *parabolic* curve; and as no form can be taken to approximate to the whole of these curves, the engineer takes that which is best adapted to the local circumstances, and constructs the *voussoirs* of such a depth that there may be no probability of the line of pressure intersecting their boundaries, or forming an angle with the bed-joints less than the complement of the angle of sliding.

We have seen that whatever form of arch may be used in a bridge, it can never in every case be symmetrical with the line of pressure, the nearest approximation being that it is included somewhere within the boundaries of the *voussoirs*. These conditions, in practice, are again greatly modified both by the workmanship and material. If at any point in the line of pressure the resisting mass be not equal to the pressure, it becomes distorted, and the strength of the arch becomes reduced to the strength of that part. In consequence of this, the bridge would be as effectually weakened or destroyed by the failure or yielding of a single part as from the disturbance of the whole structure. And when we think of this, and of the variety of circumstances above alluded to, some of which cannot with certainty be estimated, can we wonder that the failure of bridges are so frequent occurrences?

In a viaduct, which consists of a continuous row of similar arches built on the tops of slender piers, the thrust at the springing of one arch is counteracted by the equal and opposite thrust of the adjoining arches; therefore it is clear, that if one were removed the next, having no counteraction to the horizontal thrust at the springing, would likewise fall, and at the same time the next also, and so on to the end of the viaduct, one arch following the other as fast as the resistance at the base are removed. We have seen that the strength of the arch is reduced to that of the weakest part, and that it would fall with the yielding of a *voussoir*; then, since the fall of an arch would cause the fall of the whole viaduct, the strength of the whole viaduct is reduced to the weakest part of the weakest arch, and if this at any time should give way, the whole would be destroyed. In a letter to you, dated 21st July, 1845, Mr. Dredge remarks on this subject as follows:—Suppose *AabcdB*, fig. 4, to be a viaduct, consisting of three arches, and *A* and *B* the extreme abutment; now, if from defective workmanship or other causes either of these piers was to yield, the whole viaduct would of course be levelled with the ground; or suppose from the mortar not being sufficiently dry at any part, as *yz*, that part was to yield, the whole viaduct would be as effectually destroyed as in the former case, when one of the piers gave way. It remains now to show how to prove the above by a simple experiment.

The line of pressure in the compression arch is the same as a suspension chain when similarly loaded; so that if we take a chain of uniform weight, and hang it between two fixed points, *ab*, fig. 8, the curve *acdeb* assumed will be a *catenary*, if the weight be laid uniformly along the roadway, it is a *parabola*—*afghb*. If the load be at the haunches of the chain, the curve will be similar to an *ellipse*, *aiklb*; and lastly, if the weight be placed on the curve at the centre, the *Gothic*, *amnuh*, will be the form of arch. The only difference, therefore, between the curve of the line of pressure in the compression or suspension arch is position; the one curving downwards, and the other upwards, from the horizontal line. In a suspension-bridge, the curve of the chain would be the line of pressure; in a compression arch, the form of curve is positive, and the line of

pressure must always be included within its boundaries; so that in the above figure, if a semi-circular arch be used (supposing the diagram reversed, and acting on compression), the boundaries, *pqr* and *stu*, must be drawn so as to include the lines of pressure under every circumstance.

In railway bridges, the *voussoirs* immediately under the line of rails must have to resist a greater pressure than any other part of the arch.

A BRIDGE BUILDER.

January 31st.

ON THE NECESSITY OF A MORE EXTENSIVE KNOWLEDGE OF TRUE LINES,

AS ELEMENTS FOR DESIGN, AND AS THE MEANS OF JUDGING CORRECTLY OF FORM BY SIGHT.

"Judgment also will I lay to the line."

It was with much pleasure that I read the extracts from Mr. Geo. Wallis's letter in *THE BUILDER*, page 9, of this year; it exhibits some progress in the right direction. He says: "Clearness, distinctness, and precision being the end sought, as without these, intelligence in drawing (and designing) is impossible." This undoubtedly is correct; but in reference to lines, if I may judge from those enumerated, Mr. Wallis must fall very far short of what he aims at, and what ought to be taught in elementary drawing; so that whether designing or sketching from objects, artists should have the most ample stock of materials in the mind to work with, and to enable them to form a just judgment of lines by inspection.

Who, for instance, could have, without a correct example, a just notion of the true character of a wave of the development of the elliptic edge of a plain section of a cylinder? Or who could have, without a series of correct examples, a true notion of an extensive gradation of waves of that character?

Further, who can have any accurate knowledge of the orthographical projections, or the perspective representations, at different angles, of that character of wave, without true examples produced from them?

Is it not desirable to have a correct knowledge, under all these circumstances, of this most distinct character of waved lines? Surely this must be the case, and in connection with a perfect knowledge of the ellipse, for the edge of no other curve would develop the same line. Again, who, without correct examples, can have a knowledge, if I may so express it, of the family likeness of many other equally distinct characters of waved lines, and lines of many other forms, and their beautiful and harmonious gradation?

Mr. Wallis's suggestion for directing large drawings to be made by hand and eye from small ones, is just the reverse of what ought to be the practice. The most perfect lines on the most perfect planes, on as large a scale as possible to be convenient, should be the examples in the School of Design, and from such students should sketch to different smaller scales.

I am glad to see that Professor Cockerell is turning his attention to the elementary principles of design. Instead, however, of spending all efforts in research to ascertain what was the ancient practice, and then following that, which is only copying after all, would it not be better to try to discover and investigate new principles, and new applications of geometrical principles?

Had Mr. Stuart, or all those who have followed him to Greece, had the eye previously well tutored with the distinct varieties of true geometrical forms, would it not have facilitated the acquisition, and might it not have extended a knowledge of facts, as to the principles by which Greek architecture has been regulated?

Professor Donaldson has offered several suggestions to Mr. Lucas, who, I have no doubt, if he was familiar with geometrical lines of beauty, would experience great pleasure in discovering them in the most graceful forms, whether of architecture, sculpture, or the human figure, or other natural objects.

Dr. Whewell has expressed himself in a way in reference to the advantage of geometrical over analytical forms of study, which I should be glad if I could do as well, in pointing out the advantage of a much greater extension of the principles of geometry, and especially of a correct knowledge of curved lines that can be easily described and applied to architecture

and designs in general. Mr. Hay, of Edinburgh, has, I understand, been directing particular attention to the application of the ellipse; this is well, but why should not mathematical waved lines and lines of contrary flexure of an easy geometrical description be equally considered in reference to other appropriate applications?

If professors would investigate and point out appropriate applications of known curved lines, select as examples instances where they have been, and where they may be used. Point out examples of beautiful geometrical lines, for which they know not the application, and suggest these or parts of them for the consideration of students, as elements for design. By doing this they would direct a host of assistants of active minds, who by inquiring of their teachers would draw from them answers from their experience, which would suggest new applications to designs. The following question, with the answer that would be given, would elicit many other questions.

What curves, or portions of what curves, give distinctive characters to the Ionic capital?

I have watched your reports with some attention, in the hope of finding this subject alluded to by some professor of architecture.

Feb. 16th, 1846.

JOSEPH JOPLING.

ARCHITECTURAL NOMENCLATURE—PLINTH.

SIR,—That the nomenclature of architecture is exceedingly vague, meagre, and bad, is not to be disputed. Of its vagueness, a striking instance occurs on the very same page (74), where you make some observations with reference to the term "soffit." What, allow me to ask, are we to understand by the term "plinth," where it is said that the restored model of the Parthenon "shows no traces of the plinth that existed between the lower parts of the columns of the posticum?" By "plinth" is generally understood a plain and narrow, tile-shaped block, placed beneath something else, in order to raise it and give it greater stability of footing, as beneath the base of a column, a pedestal, a vase, a statue, &c.; or if it be continued along a wall, it becomes either a *socle* or a *plaisband*, according to its situation. Yet in the instance alluded to, the *plinth* is spoken of as having been not only between the columns, but nine feet and an inch high! If so, it must have formed a screen-wall of that height, between the columns of the posticum, though it seems that the latter was inclosed by a *grille* or palisading of bronze. This needs some explanation, though the description would be intelligible enough, if instead of plinth, we were to read "a screen-wall of masonry" carried up between the columns to the height mentioned, and upon that a *grille* of metal-work filling up the remainder of the inter-columns (not intercolumniations) as high as the capitals.

It is greatly to be wished (without reference to the article alluded to), that those who write architectural descriptions, would revise them, in order to see whether they are sufficiently explanatory, and in no danger of being misunderstood by those who must form their ideas of the building spoken of from the description given of it; which, by-the-by, frequently amounts to no description at all. On the other hand, where description accompanies engravings of the buildings spoken of, it is as frequently, sheer impertinence, telling us only what is plainly enough to be seen in the engraving, without further remark of any kind, and without any explanation at all in regard to a variety of particulars which cannot be made out from what is shown.

BUDOWNIN.

WORKERS IN IRON.—Jabez James, the smith whose work in the new buildings at Lincoln's Inn we had occasion to praise some time ago, has just completed a beautiful model in iron, of a large roof over the ship-building slips in one of the dock-yards. It is made very accurately, to scale; shows every bolt, distinguishes the parts that are of wrought-iron from those of cast, and is altogether greatly to the credit of its ingenious maker.

The Regent's Canal Railway project is abandoned for want of the necessary deposits. Each share is to contribute 7s. 6d. for expenses.

* When the adjoining arches are dissimilarly loaded, the thrust at the springing is not equal, and the resultant of the pressures on the slender piers is not perpendicular; thus, when the dissimilarity becomes very great, may overthrow the piers, and so destroy the structure by that means.